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Shirai

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(54) **DISPLAY INPUT DEVICE AND INFORMATION PROCESSING APPARATUS**

(71) Applicant: **KYOCERA Document Solutions Inc.**, Osaka-shi, Osaka (JP)

(72) Inventor: **Wataru Shirai**, Osaka (JP)

(73) Assignee: **KYOCERA Document Solutions Inc.**, Osaka-shi (JP)

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H04N 1/00 (2006.01)

(52) **U.S. Cl.**
CPC ***G06F 3/016*** (2013.01); ***H04N 1/00411*** (2013.01); *H04N 2201/0094* (2013.01)

(58) **Field of Classification Search**
CPC G06F 3/016; H04N 1/00411; H04N 2201/0094
See application file for complete search history.

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Primary Examiner — Andrew Sasinowski
Assistant Examiner — Chun-Nan Lin
(74) *Attorney, Agent, or Firm* — Alleman Hall McCoy Russell & Tuttle LLP

(57) **ABSTRACT**

A display input device includes a display portion, a touch panel, a piezoelectric element, a press detection portion, and a vibration control portion. The touch panel is provided on an upper surface of the display portion and configured to detect a touch operation. The piezoelectric element is provided on one or both of a front surface and a back surface of the touch panel. The press detection portion is configured to detect a press operation performed with a greater press force than in the touch operation detected by the touch panel, in accordance with output voltage from the piezoelectric element. The vibration control portion is configured to, when a press operation of the piezoelectric element is detected by the press detection portion, apply a repelling voltage for exerting a force in a direction of repelling the press operation, to the piezoelectric element.

3 Claims, 6 Drawing Sheets

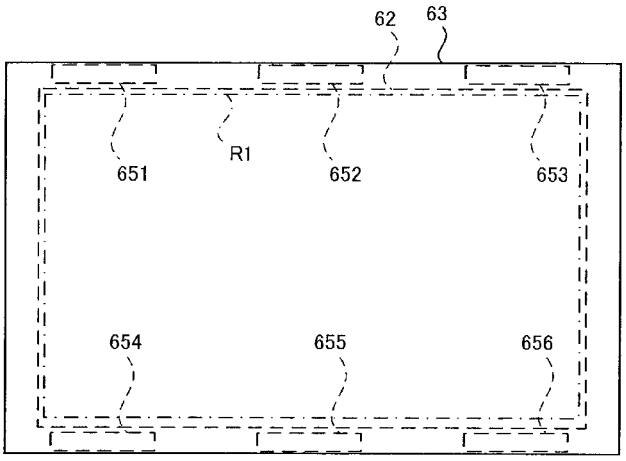


FIG. 1A

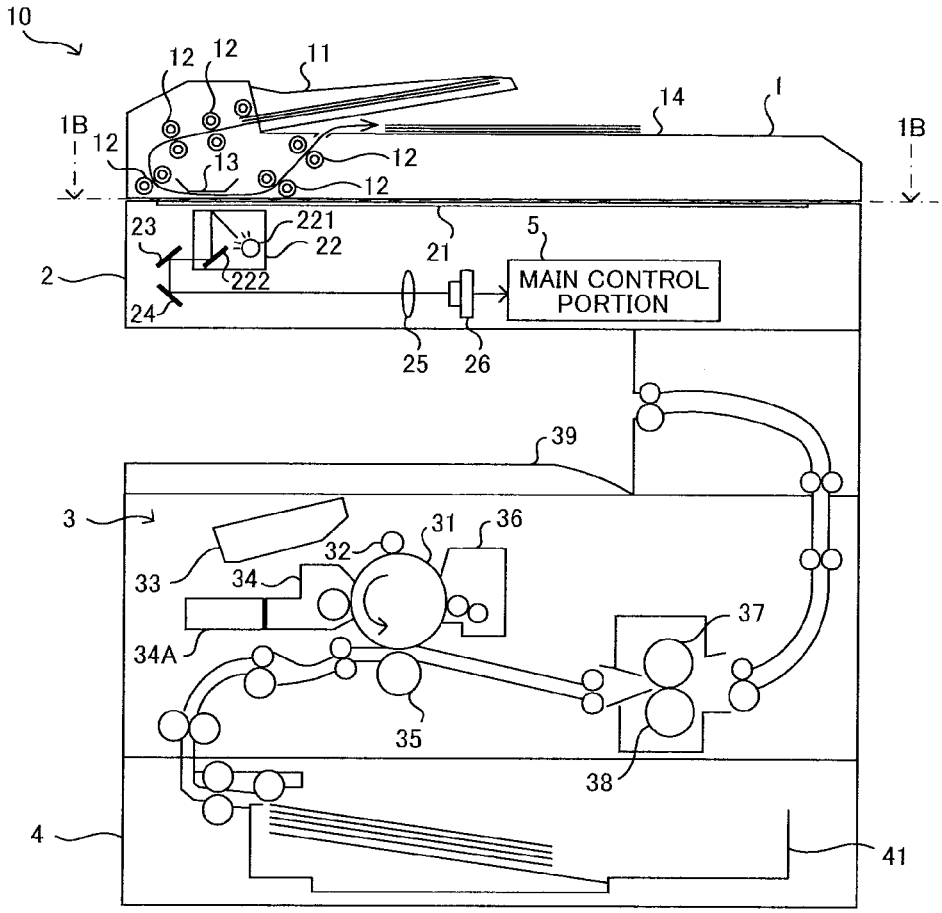
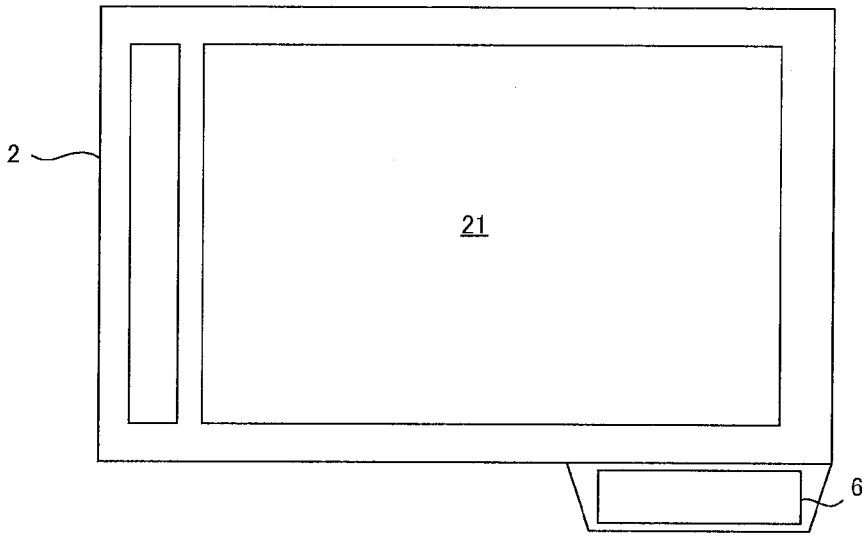

10
12
12
11
14
1
1B
12
1B
13
12
12
23
221
22
21
5
2
222
MAIN CONTROL PORTION
24
25
26
39
3
31
36
32
33
34
37
34A
35
38
4
41

FIG. 1B


2
21
6

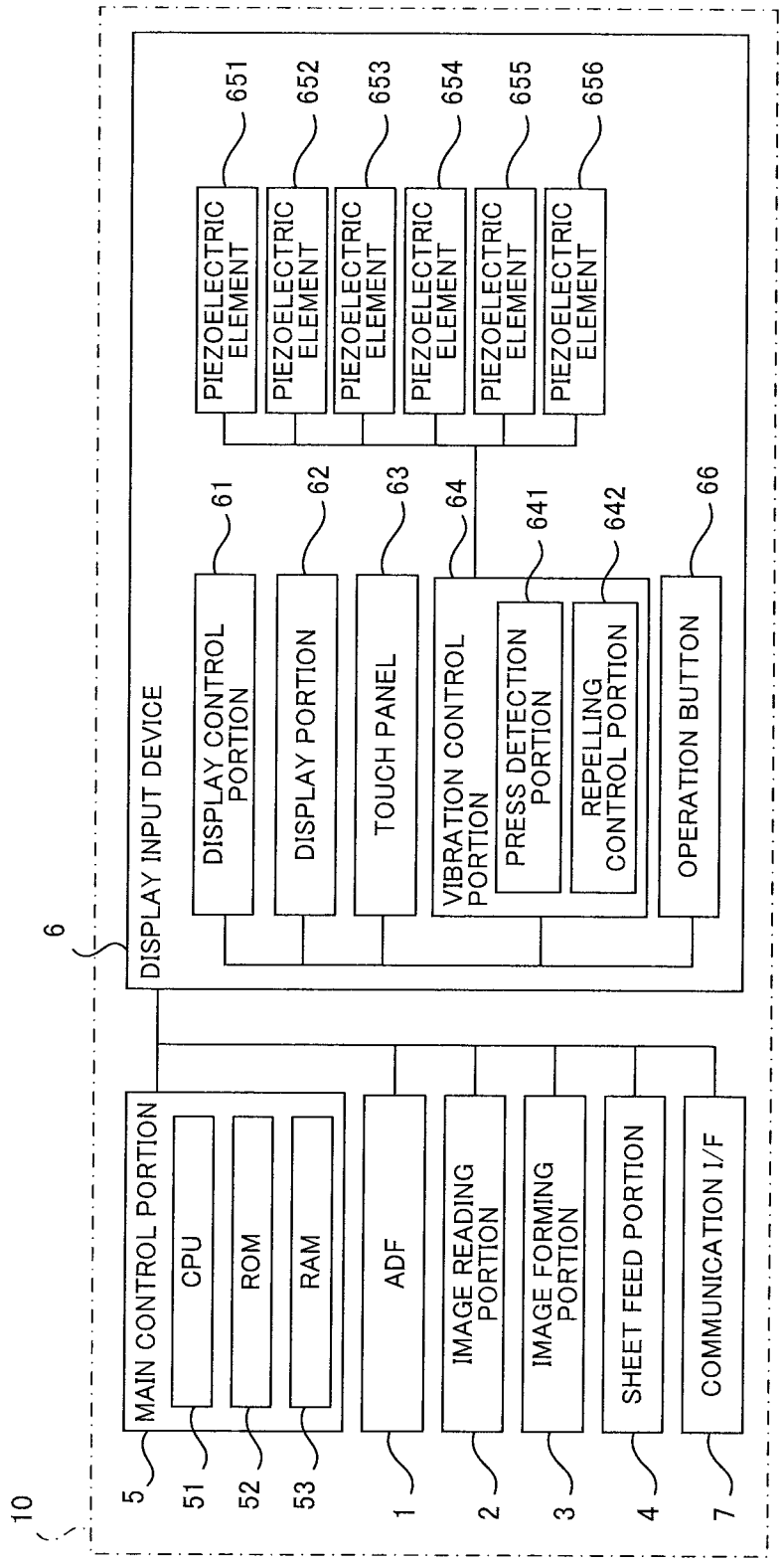

10
6
DISPLAY INPUT DEVICE
651
652
653
654
655
656
PIEZOELECTRIC ELEMENT
61
62
63
64
641
642
66
DISPLAY CONTROL PORTION
DISPLAY PORTION
TOUCH PANEL
VIBRATION CONTROL PORTION
PRESS DETECTION PORTION
REPELLING CONTROL PORTION
OPERATION BUTTON
5
MAIN CONTROL PORTION
CPU
ROM
RAM
51
52
53
1
ADF
2
IMAGE READING PORTION
3
IMAGE FORMING PORTION
4
SHEET FEED PORTION
7
COMMUNICATION I/F

FIG. 2

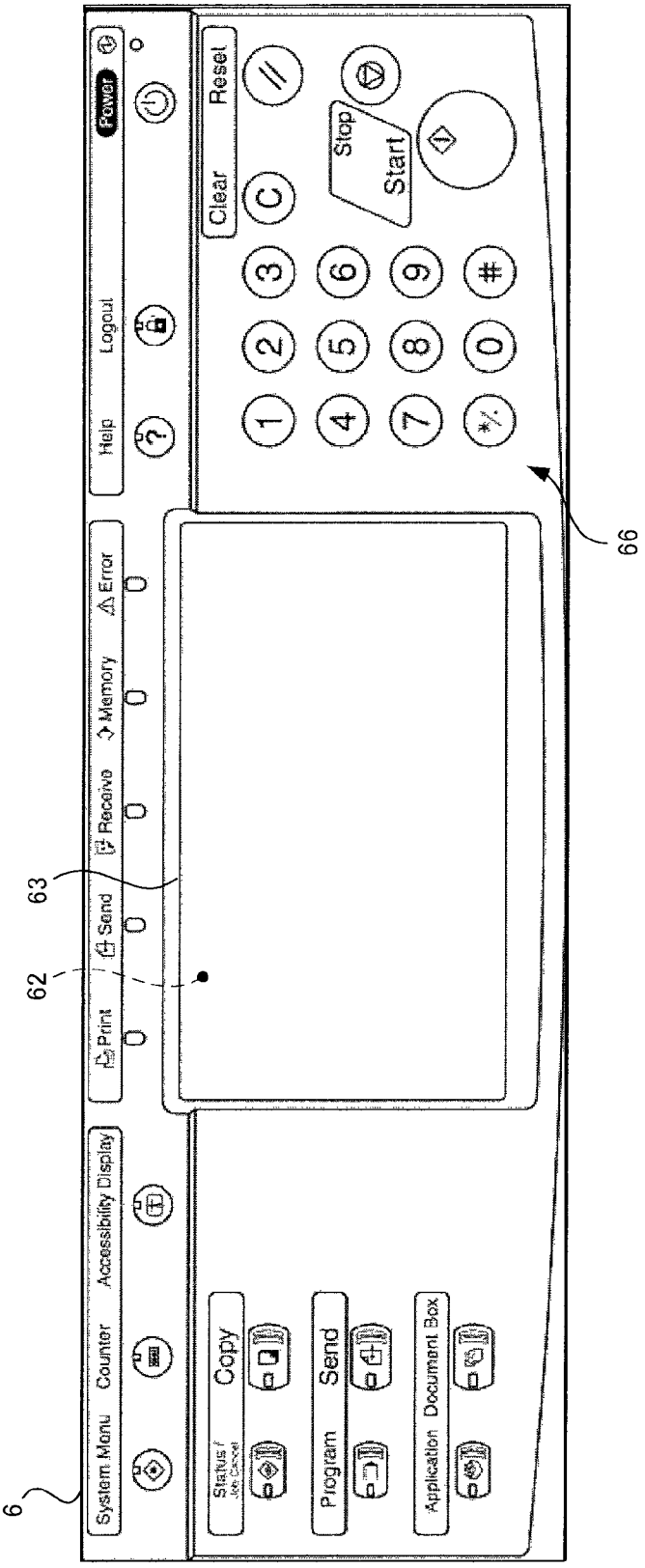

6
63
62
66
System Menu
Counter
Accessibility Display
Status / Job Cancel
Copy
Program
Send
Application
Document Box
Print
Send
Receive
Memory
Error
Help
Logout
Power
Clear
Reset
Stop
Start

FIG. 3

FIG. 4A

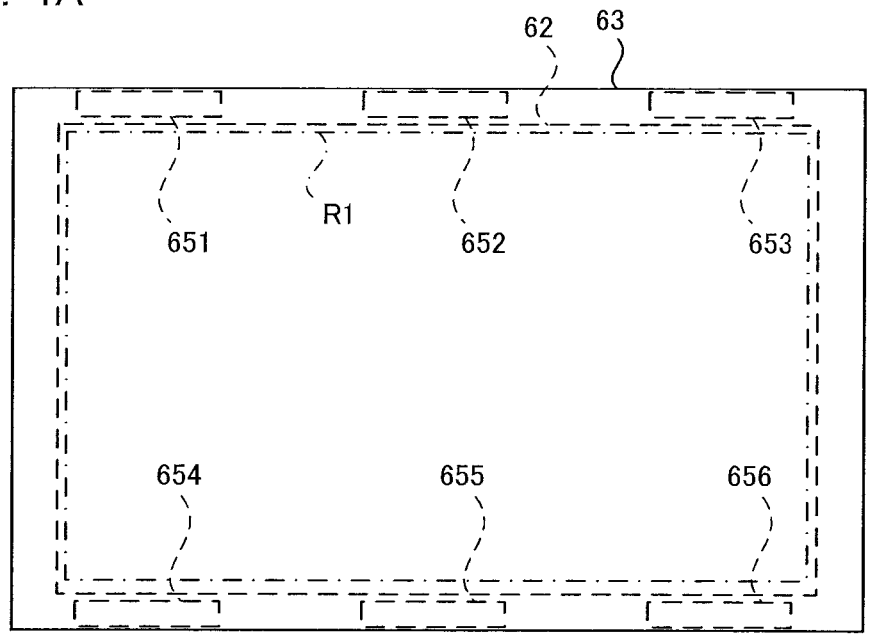


FIG. 4B

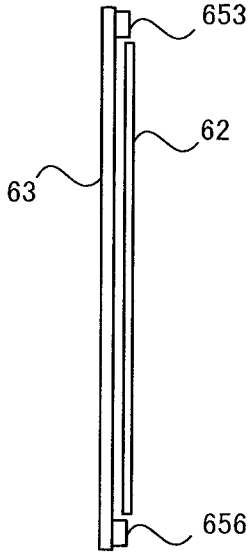
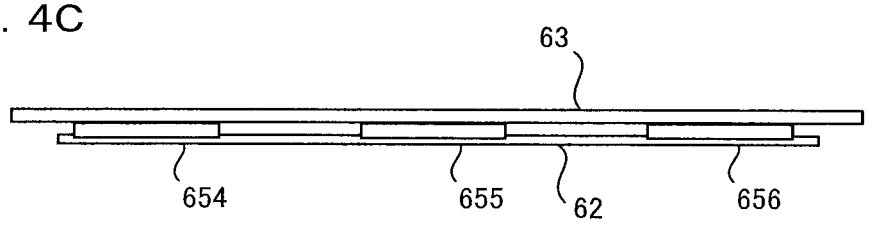


FIG. 4C



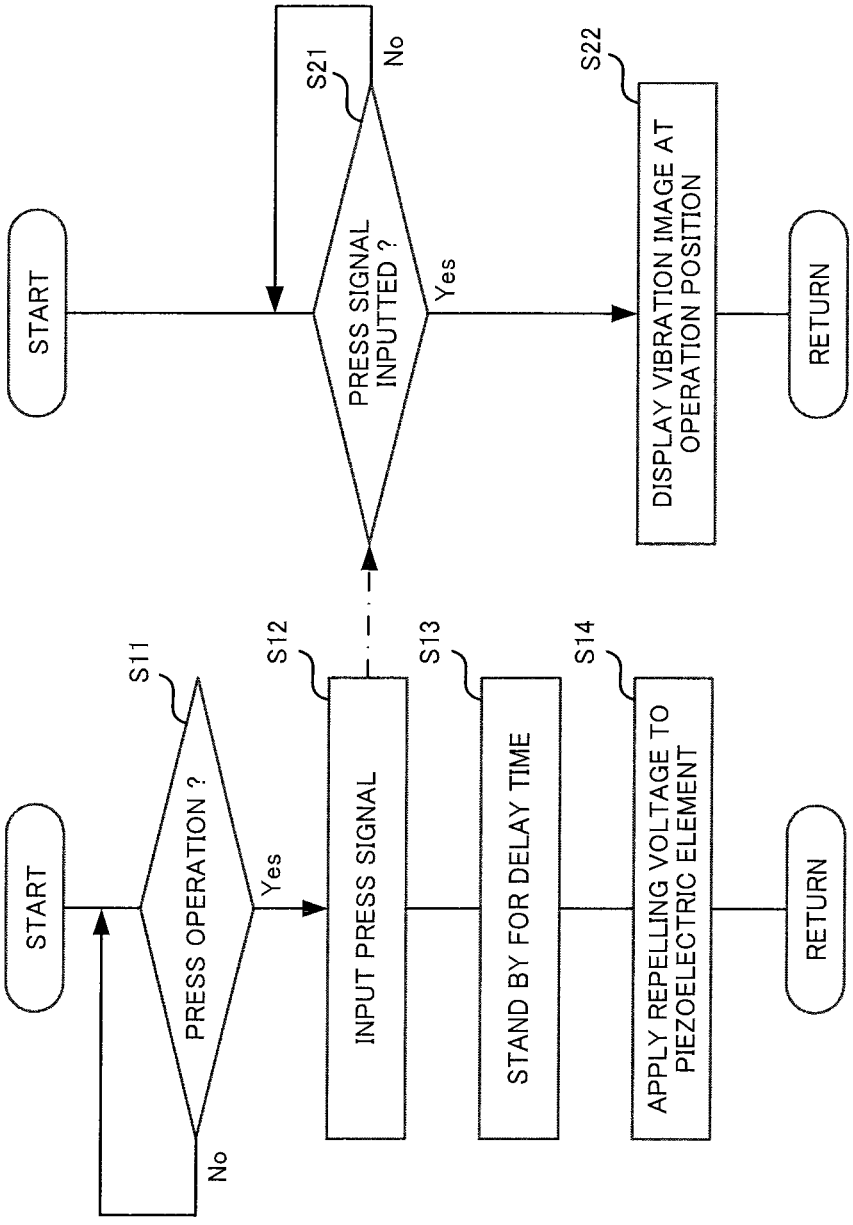

START
PRESS OPERATION ?
Yes
No
S11
INPUT PRESS SIGNAL
S12
STAND BY FOR DELAY TIME
S13
APPLY REPELLING VOLTAGE TO PIEZOELECTRIC ELEMENT
S14
RETURN
START
PRESS SIGNAL INPUTTED ?
Yes
No
S21
DISPLAY VIBRATION IMAGE AT OPERATION POSITION
S22
RETURN

FIG. 5

FIG. 6A

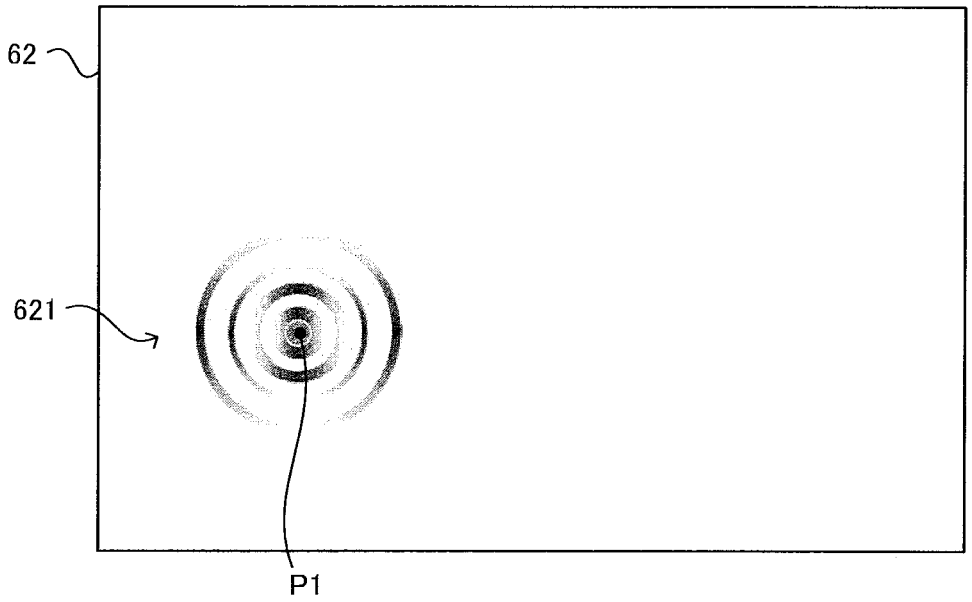
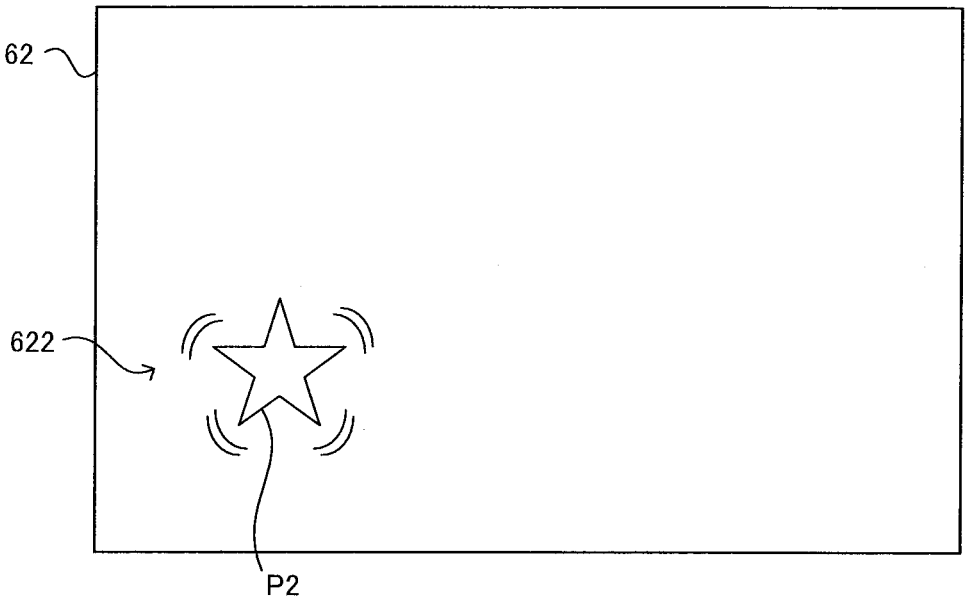


FIG. 6B



DISPLAY INPUT DEVICE AND INFORMATION PROCESSING APPARATUS

INCORPORATION BY REFERENCE

This application is based upon and claims the benefit of priority from the corresponding Japanese Patent Application No. 2013-270879 filed on Dec. 27, 2013, the entire contents of which are incorporated herein by reference.

BACKGROUND

The present disclosure relates to a display input device having a touch panel, and an information processing apparatus including the display input device.

Conventionally, there is known a display input device having a display portion on which touch keys associated with various kinds of operation contents are displayed, and a touch panel provided on the display portion, for detecting the position of a user's touch operation. A display input device of this type is used as a user interface of an information processing apparatus such as a copy machine, a facsimile device, a scanner device, a multifunction peripheral, a personal computer, or a tablet terminal, for example.

However, when operating a touch panel, a user cannot obtain a feeling of operation (click feeling) as if pressing an operation button. Regarding this, there is known a technique of, when a touch panel is operated, displaying the fact that the operation has been performed, by a vibration animation. In addition, there is known a technique of transferring a feeling of operation to a user by vibrating a touch panel when the touch panel is operated.

SUMMARY

A display input device according to one aspect of the present disclosure includes a display portion, a touch panel, a piezoelectric element, a press detection portion, and a vibration control portion. The touch panel is provided on an upper surface of the display portion and configured to detect a touch operation. The piezoelectric element is provided on one or both of a front surface and a back surface of the touch panel. The press detection portion is configured to detect a press operation performed with a greater press force than in the touch operation detected by the touch panel, in accordance with output voltage from the piezoelectric element. The vibration control portion is configured to, when a press operation of the piezoelectric element is detected by the press detection portion, apply a repelling voltage for exerting a force in a direction of repelling the press operation, to the piezoelectric element.

An information processing apparatus according to another aspect of the present disclosure includes the display input device.

This Summary is provided to introduce a selection of concepts in a simplified form that are further described below in the Detailed Description with reference where appropriate to the accompanying drawings. This Summary is not intended to identify key features or essential features of the claimed subject matter, nor is it intended to be used to limit the scope of the claimed subject matter. Furthermore, the claimed subject matter is not limited to implementations that solve any or all disadvantages noted in any part of this disclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1**A and FIG. **1**B are schematic diagrams showing the configuration of an information processing apparatus according to an embodiment of the present disclosure.

FIG. **2** is a block diagram showing the hardware configuration of the information processing apparatus according to the embodiment of the present disclosure.

FIG. **3** is a diagram showing a display input device according to the embodiment of the present disclosure.

FIG. **4**A, FIG. **4**B, and FIG. **4**C are diagrams showing the configuration of a touch panel of the display input device according to the embodiment of the present disclosure.

FIG. **5** is flowcharts showing examples of a vibration control process and a display control process executed by the display input device according to the embodiment of the present disclosure.

FIG. **6**A and FIG. **6**B are diagrams showing examples of a vibration image displayed on the display input device according to the embodiment of the present disclosure.

DETAILED DESCRIPTION

[Schematic Configuration of Image Forming Apparatus **10**]

First, the schematic configuration of an image forming apparatus **10** according to an embodiment of the present disclosure will be described. FIG. **1**A is a front schematic diagram showing the configuration of the image forming apparatus **10**, and FIG. **1**B is a view as seen from a **1**B-**1**B arrow direction in FIG. **1**A.

As shown in FIG. **1**A, FIG. **1**B, and FIG. **2**, the image forming apparatus **10** includes an ADF **1**, an image reading portion **2**, an image forming portion **3**, a sheet feed portion **4**, a main control portion **5**, a display input device **6**, a communication I/F **7**, and the like. The image forming apparatus **10** is a multifunction peripheral having a print function, a facsimile function, a scan function, a copy function, and the like. The image forming apparatus **10** is an example of an information processing apparatus according to the present disclosure. The present disclosure is also applicable to an information processing apparatus such as a printer, a facsimile, a copy machine, a personal computer, a tablet terminal, a smartphone, or a mobile phone.

The ADF **1** is an automatic document feeder including a document set portion **11**, a plurality of conveyance rollers **12**, a document presser **13**, and a sheet discharge portion **14**, as shown in FIG. **1**A. In the ADF **1**, each conveyance roller **12** is driven by a motor (not shown), whereby a document placed on the document set portion **11** passes under a lower surface of the document presser **13** which corresponds to a position for reading image data by the image reading portion **2**, and then is conveyed to the sheet discharge portion **14**. Thus, the image reading portion **2** can read image data from a document conveyed by the ADF **1**.

The image reading portion **2** includes a document table **21**, a reading unit **22**, a mirror **23**, a mirror **24**, an optical lens **25**, and a CCD (Charge Coupled Device) **26**. The document table **21** is a placement portion for a document, provided on an upper surface of the image reading portion **2**. The reading unit **22** includes an LED light source **221** and a mirror **222**, and is movable in a sub scanning direction (right-left direction in FIG. **1**A) by a motor (not shown). The LED light source **221** includes multiple white LEDs arranged along a main scanning direction (depth direction in FIG. **1**A). The mirror **222** reflects, toward the mirror **23**, light radiated from the LED light source **221** and then reflected by a surface of a document present at the reading position on the document table **21**. Then, the light reflected by the mirror **222** is guided into the optical lens **25** by the mirror **23** and the mirror **24**. The optical lens **25** converges the entering light into the CCD **26**. The CCD **26** has a photoelectric conversion

element and the like for inputting, as image data of a document, an electric signal corresponding to the reception amount of light entering from the optical lens **25**, to the main control portion **5**.

The image forming portion **3** is an image forming portion of electrophotographic type that executes image forming processing (print processing) based on image data read by the image reading portion **2** or image data inputted from an external information processing apparatus such as a personal computer. Specifically, as shown in FIG. **1**A, the image forming portion **3** includes a photosensitive drum **31**, a charging device **32**, an exposure device (LSU) **33**, a developing device **34**, a transfer roller **35**, a cleaning device **36**, a fixing roller **37**, a pressure roller **38**, and a sheet discharge tray **39**. In the image forming portion **3**, by the following procedure, an image is formed on a sheet fed from a sheet feed cassette **41** which is attachable to and detachable from the sheet feed portion **4**, and then the sheet having the image formed thereon is discharged to the sheet discharge tray **39**.

First, the photosensitive drum **31** is uniformly charged at a predetermined potential by the charging device **32**. Next, light based on image data is radiated to a surface of the photosensitive drum **31** by the exposure device **33**. Thus, an electrostatic latent image corresponding to the image data is formed on the surface of the photosensitive drum **31**. Then, the electrostatic latent image on the photosensitive drum **31** is developed (visualized) as a toner image by the developing device **34**. It is noted that toner (developer) is supplied to the developing device **34** from a toner container **34**A which is attachable to and detachable from the image forming portion **3**. Subsequently, the toner image formed on the photosensitive drum **31** is transferred onto a sheet by the transfer roller **35**. Thereafter, the toner image transferred onto the sheet is heated by the fixing roller **37** to be melted and fixed, while the sheet passes between the fixing roller **37** and the pressure roller **38**. It is noted that the remaining toner on the surface of the photosensitive drum **31** is removed by the cleaning device **36**.

The main control portion **5** has a CPU **51**, a ROM **52**, and a RAM **53**, as shown in FIG. **2**. The CPU **51** is a processor that executes various operation processes. The ROM **52** is a nonvolatile storage portion in which information such as a control program for causing the CPU **51** to execute various processes is stored in advance. The RAM **53** is a volatile storage portion and is used as a temporary storage memory (working area) for various processes executed by the CPU **51**. It is noted that the main control portion **5** may be an electric circuit such as ASIC or DSP.

The communication I/F **7** is an interface for executing data communication with an external device connected to the image forming apparatus **10** via a communication network such as the Internet or a LAN.

[Configuration of Display Input Device]

Next, the display input device **6** will be described.

As shown in FIG. **2**, FIG. **3**, FIG. **4**A, FIG. **4**B, and FIG. **4**C, the display input device **6** includes a display control portion **61**, a display portion **62**, a touch panel **63**, a vibration control portion **64**, a plurality of piezoelectric elements **651** to **656**, and an operation button **66**. As shown in FIG. **3**, the operation button **66** includes various hardware keys such as a numerical keypad and a start key, and inputs an operation signal of each hardware key to the display control portion **61**. It is noted that FIG. **4**A is a plan view of the touch panel **63**, FIG. **4**B is a left side view of the touch panel **63**, and FIG. **4**C is a front view of the touch panel **63**.

The display control portion **61** has a CPU, a RAM, and a ROM. The CPU is a processor that executes various operation processes. The ROM is a nonvolatile storage portion in which information such as a control program for causing the CPU to execute various processes is stored in advance. In addition, in the ROM, a vibration image visually indicating that the touch panel **63** is operated is stored. It is noted that the vibration image is a concept including a still image and a moving image. The RAM is a volatile storage portion and is used as a temporary storage memory (working area) for various processes executed by the CPU. The display control portion **61** may be an electric circuit such as ASIC or DSP. In another embodiment, the main control portion **5** may also have the function of the display control portion **61**.

The display control portion **61** controls display of the display portion **62** in accordance with a control instruction from the main control portion **5**. The display portion **62** is, for example, a liquid crystal display panel or an organic EL display. The display portion **62** is controlled by the display control portion **61**, to display various kinds of information. For example, on the display portion **62**, various kinds of information such as a touch key and a setting screen associated with various operation contents are displayed. The display control portion **61** inputs various operation signals to the main control portion **5** in accordance with a touch operation on the touch panel **63** or an operation on the operation button **66** by a user.

The touch panel **63** is provided on an upper surface of the display portion **62**, as shown in FIG. **4**B and FIG. **4**C. The display portion **62** and the touch panel **63** are supported by a supporting member (not shown). The outer diameter of the touch panel **63** is greater than that of the display portion **62**. A region R**1** shown in FIG. **4**A is a region where the touch panel **63** is exposed on the display input device **6**. A region outside the region R**1** is covered by a housing of the display input device **6** so that the outside region is invisible to a user who operates the display input device **6**.

The touch panel **63** detects a user's touch operation, and inputs position information indicating the position of the touch operation to the display control portion **61**. As a result, the display control portion **61** can input, to the main control portion **5**, an operation signal set in advance as an operation content associated with the position of the touch operation on a current display screen of the display portion **62**. Specifically, the touch panel **63** is a resistive touch panel which detects an operation position based on change in resistance. It is noted that the touch panel **63** may be an electrostatic capacitance touch panel which detects an operation position based on change in electrostatic capacitance.

The piezoelectric elements **651** to **653** are provided on a back surface of the touch panel **63**. More specifically, as shown in FIG. **4**A, the piezoelectric elements **651** to **653** are arranged at a predetermined interval at an upper end portion (one end in the short-side direction) of the touch panel **63** along the long-side direction of the touch panel **63**. In addition, as shown in FIG. **4**A, the piezoelectric elements **654** to **656** are arranged at a predetermined interval at a lower end portion (one end in the short-side direction) of the touch panel **63** along the long-side direction of the touch panel **63**. It is noted that the piezoelectric elements **651** to **656** are located in the region outside the region R**1** so that they are invisible to a user. In addition, the piezoelectric elements **651** to **653** and the piezoelectric elements **654** to **656** are located so as to respectively oppose to each other in the short-side direction of the touch panel **63**. It is noted that each of the piezoelectric elements **651** to **656** is composed of a piezoelectric body of a piezoelectric ceramic such as PZT (lead zirconate titanate), and a pair of electrodes sandwiching this.

The vibration control portion **64** has a CPU, a RAM, and a ROM. The CPU is a processor that executes various operation processes. The ROM is a nonvolatile storage portion in which information such as a control program for causing the CPU to execute various processes is stored in advance. The RAM is a volatile storage portion and is used as a temporary storage memory (working area) for various processes executed by the CPU. The vibration control portion **64** may be an electric circuit such as ASIC or DSP. In another embodiment, the main control portion **5** or the display control portion **61** may also have the function of the vibration control portion **64**.

The vibration control portion **64** is electrically connected to each of the piezoelectric elements **651** to **656**. Voltages generated in the piezoelectric elements **651** to **656** when distortion occurs in the piezoelectric elements **651** to **656** are inputted to the vibration control portion **64**. Then, the vibration control portion **64** detects a user's press operation on the touch panel **63** in accordance with output voltages from the piezoelectric elements **651** to **656**. More specifically, when a press force greater than that of a touch operation detected by the touch panel **63** acts on the touch panel **63**, and a voltage equal to or greater than a predetermined threshold value is inputted as voltages outputted from the piezoelectric elements **651** to **656**, the vibration control portion **64** detects that the press operation has been performed. Here, the vibration control portion **64**, when detecting a press operation on the touch panel **63**, is an example of a press detection portion.

In addition, the vibration control portion **64** can displace each of the piezoelectric elements **651** to **656** to generate vibration, by applying voltage supplied from a power supply (not shown) to each of the piezoelectric elements **651** to **656**. In the image forming apparatus **10**, when the touch panel **63** is operated, a feeling of operation is transferred to a user by using vibration of the piezoelectric elements **651** to **656**. More specifically, when a user's operation is performed on the touch panel **63**, the vibration control portion **64** applies a repelling voltage for exerting a force in a direction of repelling the user's operation, to the piezoelectric elements **651** to **656**, thereby transferring a feeling of the operation to the user. For example, the repelling voltage is a voltage having a polarity opposite to voltages generated in the piezoelectric elements **651** to **656** when a user performs a press operation on the piezoelectric elements **651** to **656**.

When a user slightly touches the touch panel **63**, no distortion occurs in the piezoelectric elements **651** to **656**. Therefore, even if a repelling voltage for exerting a force in a direction of repelling the user's operation is applied to the piezoelectric elements **651** to **656**, a repelling force transferred to the user by the piezoelectric elements **651** to **656** is small, and a feeling of the operation cannot be sufficiently transferred to the user. On the other hand, the image forming apparatus **10** can effectively transfer a feeling of operation on the touch panel **63** to a user, using the piezoelectric elements **651** to **656**, as described later.

Hereinafter, with reference to a flowchart in FIG. **5**, a vibration control process and a display control process executed by the image forming apparatus **10** will be described. The vibration control process is executed by the vibration control portion **64**, and the display control process is executed by the display control portion **61**. The display control portion **61** also executes, besides the display control process described here, processing of detecting a touch operation on the touch panel **63**, processing of causing the display portion **62** to display various kinds of information, and the like, but the description thereof is omitted here.

[Vibration Control Process]

<Step S11>

First, in step **S11**, the vibration control portion **64** waits for a press operation on the touch panel **63** (**S11**: No). Specifically, when a voltage equal to or higher than a predetermined threshold value is inputted by any of the piezoelectric elements **651** to **656**, the vibration control portion **64** determines that a press operation has been performed on the touch panel **63**. That is, in the display input device **6**, a press operation on the touch panel **63** is an operation detected separately from a touch operation on the touch panel **63**. Therefore, in a process of a user operating the touch panel **63**, at a point when a touch operation is performed on the touch panel **63**, the process stands by at the step **S11**, and thereafter, at a point when the touch panel **63** is further pressed, it is determined that the press operation has been performed. Then, if a press operation has been performed on the touch panel **63** (**S11**: Yes), the process shifts to step **S12**.

<Steps S12 and S13>

In step **S12**, the vibration control portion **64** inputs a press signal indicating that the press operation has been performed on the touch panel **63**, to the display control portion **61**. Thereafter, the vibration control portion **64** stands by until a delay time elapses which is set in advance as a required time since the display control portion **61** has received the press signal until the vibration image is displayed as described later. The delay time is a time set in advance in order to synchronize vibration of the piezoelectric elements **651** to **656** with display of the vibration image by the display control portion **61**. In another embodiment, the standby for the delay time may be omitted.

<Step S14>

Then, after the delay time has elapsed, in step **S14**, the vibration control portion **64** applies the repelling voltage to the piezoelectric elements **651** to **656**, thereby vibrating the piezoelectric elements **651** to **656**. More specifically, the vibration control portion **64** applies the repelling voltage for exerting a force in a direction of repelling the user's press operation, to the piezoelectric elements **651** to **656**. Here, the vibration control portion **64**, when applying the repelling voltage to the piezoelectric elements **651** to **656**, is an example of a vibration control portion.

As a result, each of the piezoelectric elements **651** to **656** is displaced in a direction opposite to the user's pressing direction in accordance with the repelling voltage applied by the vibration control portion **64**, thereby making an impact on the user. Thus, when a user operates the touch panel **63**, the user can obtain a feeling of the operation by an impact transferred from the piezoelectric elements **651** to **656**. Particularly, the vibration control portion **64** applies the repelling voltage to the piezoelectric elements **651** to **656**, not when a touch is detected on the touch panel **63**, but when a user's press operation is detected based on output voltages from the piezoelectric elements **651** to **656**. Therefore, the piezoelectric elements **651** to **656** are displaced in an opposite direction when they are sufficiently distorted, so that a feeling of operation can be effectively given to a user. In another embodiment, after applying the repelling voltage, the vibration control portion **64** may apply a vibration waveform such as a sine wave, a rectangular wave, a triangle wave, or a saw-tooth wave to the piezoelectric elements **651** to **656**, to continue the vibration.

[Display Control Process]

<Step S21>

Meanwhile, in step **S21**, the display control portion **61** waits for reception of the press signal from the vibration

control portion **64** (S**21**: No). Then, when the display control portion **61** receives the press signal from the vibration control portion **64** (S**21**: Yes), the display control portion **61** shifts the process to step S**22**.

<Step S**22**>

In step S**22**, the display control portion **61** causes the display portion **62** to display the vibration image stored in the ROM of the display control portion **61**. Thus, the user can visually recognize that the operation has been accepted when the user has operated the touch panel **63**, from the display of the vibration image on the display portion **62**.

Here, FIG. **6**A and FIG. **6**B are diagrams showing examples of the vibration image. In the example shown in FIG. **6**A, a ripple image **621** broadening around an operation position P**1** on the touch panel **63** is displayed as the vibration image on the display portion **62**. In the example shown in FIG. **6**B, swing of an icon image **622** displayed at an operation position P**2** on the touch panel **63** is displayed as the vibration image on the display portion **62**. As other examples of the vibration image, an image of a distorted shape of an operated icon, or vibration of the entire display screen on the display portion **62** may be used.

Thus, in the image forming apparatus **10**, vibration of the piezoelectric elements **651** to **656** by the vibration control portion **64** and display of the vibration image on the display portion **62** by the display control portion **61** are both executed. Therefore, the image forming apparatus **10** can effectively transfer, to a user, that an operation on the touch panel **63** has been accepted, by vibration of the piezoelectric elements **651** to **656** and display of the vibration image. Particularly, in the image forming apparatus **10**, since the standby processing in the step S**13** is executed by the vibration control portion **64**, it is possible to simultaneously execute vibration of the piezoelectric elements **651** to **656** and display of the vibration image.

In the display input device **6** according to the present embodiment, the piezoelectric elements **651** to **656** are provided on a back surface of the touch panel **63**. However, in another embodiment, the piezoelectric elements **651** to **656** may be provided in a divided manner on a front surface and a back surface of the touch panel **63**. For example, among the piezoelectric elements **651** to **656**, the piezoelectric element **652** and the piezoelectric element **655** which are positioned at the center may be provided on a front surface of the touch panel **63**, and the piezoelectric element **651**, **653**, **654**, and **656** may be provided on a back surface of the touch panel **63**. As a matter of course, in another embodiment, the piezoelectric elements **651** to **656** may be provided on a front surface of the touch panel **63**.

In another embodiment, in the step S**14**, the vibration control portion **64** may apply the repelling voltage only to a piezoelectric element that is set in advance as a piezoelectric element corresponding to a touch position detected on the touch panel **63**, among the piezoelectric elements **651** to **656**. Specifically, piezoelectric elements respectively corresponding to predetermined regions on the touch panel **63** are defined, and the vibration control portion **64** applies the repelling voltage only to a piezoelectric element corresponding to the region to which the touch position detected on the touch panel **63** belongs. Thus, only a piezoelectric element that is close to the touch position is vibrated, whereby, for example, a situation in which a plurality of piezoelectric elements **651** to **656** are simultaneously vibrated and their vibrations are cancelled by each other can be avoided. The vibration control portion **64** may detect the position of a press operation on the touch panel **63** in accordance with a predetermined arithmetic expression indicating the relationship between voltage values outputted from the piezoelectric elements **651** to **656** and the position of a press operation.

In display of a vibration image on the display portion **62** in the step S**22**, the vibration image to be displayed may be changed in accordance with a press signal generated by a press operation being performed on the touch panel **63** in the step S**12**, that is, in accordance with a press amount (strength of press) on the touch panel **63**. For example, in FIG. **6**A, as the press amount (strength of press) on the touch panel **63** increases, the ripple image **621** broadening around the operation position P**1** may be displayed so as to broaden to a farther distance. In FIG. **6**B, as the press amount (strength of press) on the touch panel **63** increases, the icon image **622** displayed at the operation position P**2** may be displayed so as to swing more greatly.

In execution of both of vibration of the piezoelectric elements **651** to **656** by the vibration control portion **64** and display of the vibration image on the display portion **62** by the display control portion **61**, the vibration of the piezoelectric elements **651** to **656** may be increased in accordance with the press amount (strength of press) on the touch panel **63**, that is, as the press amount (strength of press) on the touch panel **63** increases, while the vibration image to be displayed is changed as described above.

In the step S**22**, a vibration image is displayed on the display portion **62**. However, in the case where a user slightly operates the touch panel **63** in the step S**12**, a repelling force transferred to the user by the piezoelectric elements is small, and a feeling of the operation cannot be sufficiently transferred to the user. Therefore, only when a user slightly operates the touch panel **63**, the vibration image may be displayed in order to sufficiently transfer the operation feeling to the user.

In execution of both of vibration of the piezoelectric elements **651** to **656** by the vibration control portion **64** and display of the vibration image on the display portion **62** by the display control portion **61**, the vibration of the piezoelectric elements **651** to **656** may be increased in accordance with the press amount (strength of press) on the touch panel **63**, that is, as the press amount (strength of press) on the touch panel **63** increases.

It is to be understood that the embodiments herein are illustrative and not restrictive, since the scope of the disclosure is defined by the appended claims rather than by the description preceding them, and all changes that fall within metes and bounds of the claims, or equivalence of such metes and bounds thereof are therefore intended to be embraced by the claims.

The invention claimed is:

1. A display input device comprising:

a display portion;

a touch panel provided on an upper surface of the display portion and configured to detect a touch operation;

a plurality of piezoelectric elements provided in a divided manner on both of a front surface and a back surface of the touch panel;

circuitry of a display control portion configured to control display of the display portion;

circuitry of a press detection portion configured to detect, separately from the touch operation, a press operation performed with a greater press force than in the touch operation detected by the touch panel, in accordance with output voltage from the piezoelectric elements; and

circuitry of a vibration control portion that stands by waiting for a press operation at a point when the touch operation is detected, and is configured to, when a press

operation of the piezoelectric elements is detected by the press detection portion, input a press detection signal to the display control portion and apply a voltage having a polarity opposite to the output voltage, as a repelling voltage for exerting a force in a direction of repelling the press operation, to the piezoelectric element, wherein

the plurality of piezoelectric elements include three piezoelectric elements arranged at an upper end portion of the touch panel and three piezoelectric elements arranged at a lower end portion of the touch panel, and among each of the three piezoelectric elements arranged at the upper end portion of the touch panel and the three piezoelectric elements arranged at the lower end portion of the touch panel, a piezoelectric element positioned at a center is provided on a front surface of the touch panel and the other two piezoelectric elements are provided on a back surface of the touch panel,

when the press detection signal is inputted, the display control portion causes the display portion to display, as a vibration image, a moving image showing vibration of an entire screen of the display portion, and

after the vibration control portion has inputted the press detection signal to the display control portion, when a delay time has elapsed which is set in advance as a required time until the signal display is executed by the display control portion, the vibration control portion applies the repelling voltage to the piezoelectric elements.

2. The display input device according to claim **1**, wherein circuitry of the vibration control portion applies the repelling voltage only to the piezoelectric element that is set in advance so as to be associated with a position of the touch operation detected by the touch panel.

3. An information processing apparatus comprising the display input device according to claim **1**.

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